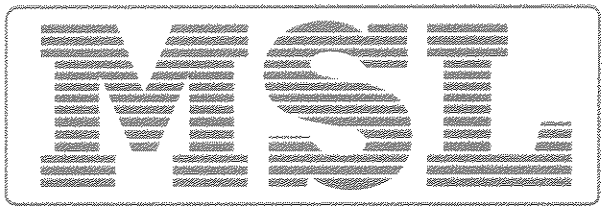
PROJECT 227



JOINT INDUSTRY PROJECT

DEVELOPMENT OF GROUTED TUBULAR JOINT TECHNOLOGY FOR OFFSHORE STRENGTHENING AND REPAIR

SPECIFICATION AND PROCEDURE FOR GROUTING OF TEST SPECIMENS

DOC REF C14100R006 Rev 1 DECEMBER 1994

MSL Engineering Limited

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CONTENTS

1. INTRODUCTION

This document presents a detailed procedure for the chord grout-filling of tubular joints to be used as test specimens in a Joint Industry Project (JIP) on the 'Development of Grouted Tubular Joint Technology for Offshore Strengthening and Repair'.

The tubular joints will be used for SCF tests for the ungrouted and grouted conditions. Once tests are complete for the ungrouted condition, grouting can commence in accordance with the specifications and procedure presented within this document.

This document makes reference to the following American Standards:-

- API Specification 10 - Specification for Materials and Testing for Well Cements
- ASTM Specification C150 - Standard Specification for Portland Cement.

2. GROUT FILLING OF SPECIMENS

2.1 General Description

The tubular joint specimens comprise T joints and DT/X Joints. Each of the tubular joints is to be chord grout-filled for SNCF measurements and subsequent ultimate strength tests.

The tubular joints are to be cast with the chord placed in the vertical position. This will ensure complete grout filling of the chord and reduce the number of parameters to consider when interpreting test results. Displacement of water whilst grout filling will be a requirement since grouting offshore in strengthening/repairs will also displace water.

The grout mix and testing specification shall conform to Section 3 herein.

Tubular joints shall be grout-filled using the same procedures, mixing equipment and facilities. This will ensure consistency in grout mix, test cube preparation, grout placement and grout strength once cured. Grout mixer capacity may limit the number of specimens that can be grouted in one operation. In this case measures will be taken to ensure consistency between batches.

2.2 Grout Connections

Grout connection arrangements are shown in Figures 2.1 and 2.2.

For each tubular joint, one inlet shall be provided at the base of the vertical chord and the outlet in either the top cover plate or the top of the chord. The operation of all valves shall be checked, prior to fitting.

All connections shall be well greased. The grout inlet shall be attached to the chord at the grout inlet point. All grout shall be input through this point.

2.3 Filling Chord with Water

The vertical chord members shall be filled with water prior to grout filling. Any leaks identified shall be remedied prior to the grouting operation.

2.4 Grouting the Tubular Joints

This operation shall follow immediately after successful filling of the chord with water.

2.4.1 Mix grout

Grout shall be mixed to a specific gravity of 2.02 $\pm$ 0.02 for Oilwell or Portland cement or 1.98 $\pm$ 0.02 for Encelite cement (see Section 3.2 for cement specification). Confirmation of the specific gravity shall be carried out using a pressurised mud-balance. If acceptable, samples will be taken for grout cubes. If the specific gravity is not within the limits specified above, grout shall be mixed until desired density is achieved. Samples for grout cubes will then be taken.

See Section 3 for mixing, sampling and testing of grout.

2.4.2 Grouting operation

- Ensure grout inlet hose is free of any obstructions, 'kinks' or 'crimps' when connected to test specimen.
- Open inlet valves.
- Begin pumping grout through the inlet hose. Pump continuously.
- When good consistency grout flows from the chord outlet point, continue pumping slowly, and take density measurements.
- Following confirmation of satisfactory grout densities, stop pumping, and close inlet valves. Disconnect quick release coupling and reconnect to next specimen. Open inlet valves and begin pumping. When good consistency grout flows from the outlet point, continue pumping slowly and take density measurement. Repeat this cycle for subsequent tubular joints.
- Once all tubular joints are grouted, disconnect grout inlet at quick release union connection, open valve connected to inlet line and pump water down the grout inlet line, to flush.

2.4.3 Short stoppages

If a blockage occurs during grouting of a specimen, adopt the following procedure:-

Stop pumping

Close both inlet valves at inlet point. Disconnect grout line at quick release union connection.

Open grout line inlet valve.

Begin pumping slowly.

If no grout flows, change the inlet grout hose. If grout flows, the problem is not in the hose. Therefore, it is a fault either in the inlet valve, the outlet hose or in the tubular specimen.

Reconnect grout inlet and open inlet valve. Begin pumping. If grout does not flow, then a piece of wire inserted through the outlet point may prove successful in removing any blockage there. If grout still does not flow then the blockage is at the inlet valve or within the tubular specimen and the following course of action may be taken.

- Abort the grouting operation, remedy the fault at the inlet valve or from within the tubular specimen and instigate flushing procedures.

Specimens successfully grouted prior to blockage, shall remain grouted.

2.4.4 Longer stoppages

In the event of a grout flow problem or delay during grouting operations of a specimen, where such delays may exceed one hour, chord flushing procedures must start.

2.4.5 Flushing procedure

Flushing must be carried out if grout flow problems occur which may delay operations for more than one hour.

Specimens successfully grouted prior to blockage, shall remain grouted.

(i) Disconnect grout inlet at quick release union connection, open valve connected to inlet hose and flush inlet hose. Wash out grout mixer.

(ii) Inspect all valves and 'rake out' where necessary.

(iii) Flush specimen through either the inlet or outlet points.

2.5 Post Grouting Procedure

Immediately after satisfactory grouting, close all inlet valves, disconnect at quick release union, open valve connected to inlet hose and flush the grout inlet line.

3. GROUT MIX AND TESTING SPECIFICATION

3.1 Design Requirements

All grout to be used shall achieve a minimum compressive strength of 41.4 N/mm^2 (6000 psi) at 28 days.

3.2 Materials

Cement shall be class 'B' or 'G' oilwell cement to API Spec 10. Alternatively, sulphate resisting Portland Cement to ASTM C150 Type II or Dutch Encelite Portland Class B may be substituted and used in the same proportions.

Manufacturer's Certificates of Quality with respect to the materials shall be obtained before use.

The cement shall be stored and transported in accordance with the manufacturer's instructions. The cement shall be kept free from moisture at all times and a careful visual inspection of all materials shall be made prior to their use to ensure their suitability for the work. Cement shall be stored out of direct sunlight.

Drinkable water is to be used for mixing, with a temperature not exceeding 20°C.

3.3 Grout Mix Proportions

The grout mix shall be as follows:-

Cement	-	100 parts by weight
Water	-	34 parts by weight (for Oilwell or Portland cement)
	-	39 parts by weight (for Encelite cement)

NO ADMIXTURES SHALL BE PERMITTED

Figure 3 shows the rate of gain of strength for Oilwell 'B' grouts cured at 8°C (46°F). This is based upon extensive onshore and offshore test data collated from many years of grouting experience.

3.4 Grout Mixing

The grout shall be mixed using a recirculating jet type mixer (eg. Craelius CEMIX 175 or Colcrete DD4). An initial mix shall be made to line the mixer. This mix shall be discarded. Subsequent batches shall be used to grout the specimens. All batches shall be mixed for a minimum of two minutes.

3.5 Slurry Density Measurements

Measurement of slurry densities shall be made using a pressurised slurry density balance in the manner described in API Spec. 10. Particular attention shall be paid to ensure that the external surfaces of the balance are cleaned and dried after filling and prior to balancing.

Grout shall not be pumped until a specific gravity within the limits noted in Section 2.4.1 is achieved. Slurry densities shall be checked immediately prior to pumping and throughout the grouting operations, sampling every batch mixed.

3.6 Cube Preparation and Curing

Cubes shall be cast in accordance with API Spec. 10, with the exception that 75mm (3 inch) cubes shall be used.

The cubes shall be placed in polyurethane bags immediately after casting and cured with and at the same temperature as the grouted joints until removed for demolding or testing.

Cubes may be demolded after 24 hours. The total time out of the bags must not be more than 1 (one) hour. Cubes shall be weighed, measured and crushed within 30 minutes of removal from the bags.

The cube age shall be measured from the time the cube is struck to the time it is crushed.

Each cube shall be marked with a unique mark and this mark correlated with the batch number, specimen number, time and date made and slurry density, as measured by a pressurised slurry density balance.

3.7 Sampling and Testing Procedures

For each batch 4 N° cubes are to be cast from the grout in the grout mixer.

From the 4 N° cubes cast from the grout in the mixer, three (3 N°) cubes shall be tested at 28 days.

An additional 8 N° cubes are to be cast for each grouted test specimen.

From the 8 N° cubes cast with each specimen;

Three (3 N°) cubes shall be tested at the commencement of SCF tests on each grouted specimen.

Three (3 N°) cubes shall be tested at the commencement of ultimate strength tests on each grouted specimen.

Each cube shall be crushed in accordance with the procedure given in API Spec. 10, except that the rate of loading will be no faster than 14 N/mm² per min (2000 lbf/in² per min).

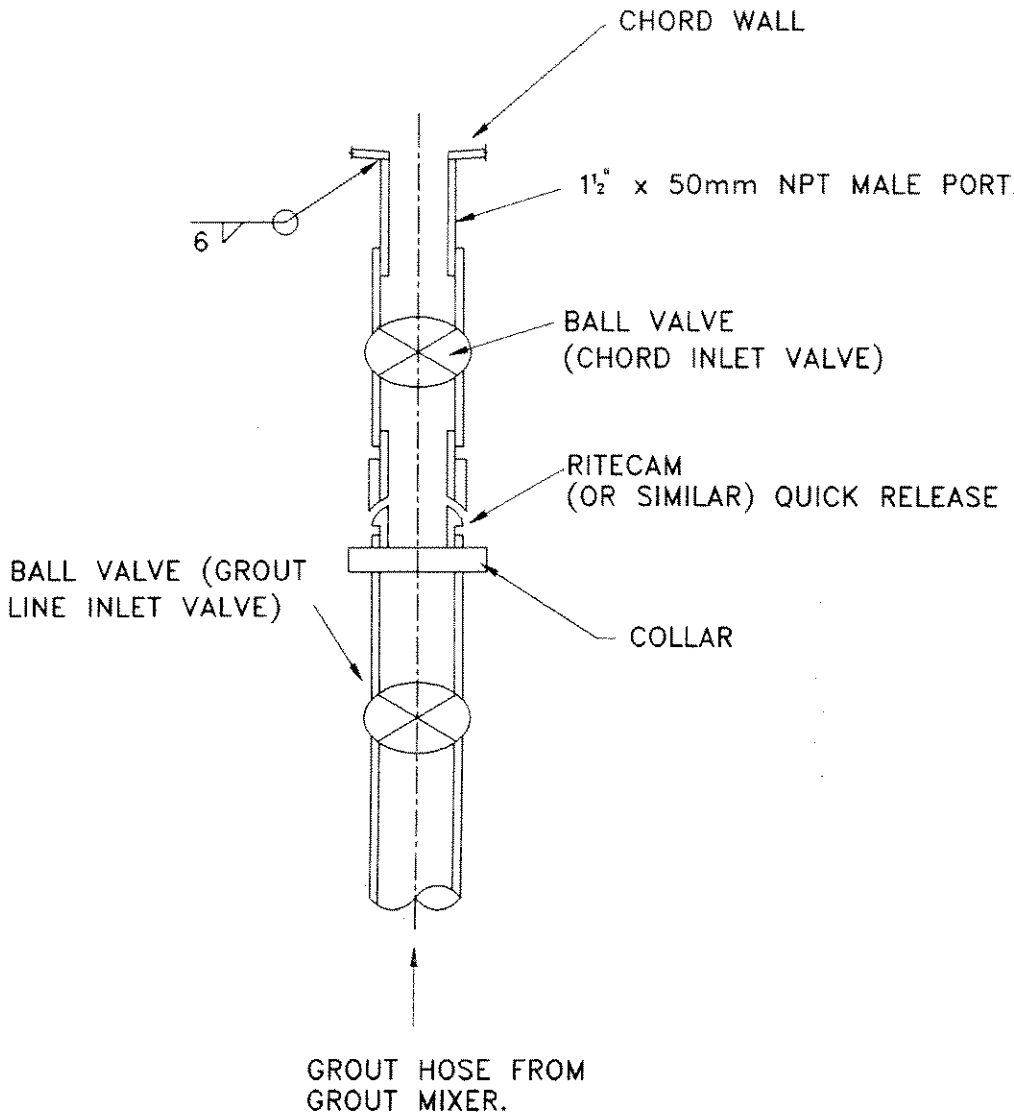
The following information shall be collated for the final report:-

- Test specimen identification reference
- Cube identification reference
- Time and date of casting of the cube and test specimen
- Time and date of testing of the cube and test specimen
- Fluid grout density at time of casting
- Weight and density of the grout cube
- Failure load and cube strength
- Average strength from 3 N° cubes tested at 28 days.
- Average strength from the 3 N° cubes tested at commencement of SCF test on each grouted specimen and 3 N° cubes tested at commencement of ultimate strength test on each grouted specimen.

3.8 Equipment

Calibration certificates are to be supplied for all weighing, balancing, cube making and cube crushing equipment.

FIGURES



NOTES:–
1. DIMENSIONS TO ALLOW CLEARANCES TO OPERATE VALVE HANDLES.
2. ALL VALVES TO BE 1½" BALL VALVES.

FIGURE 2.1. ARRANGEMENT OF CHORD GROUT INLET.

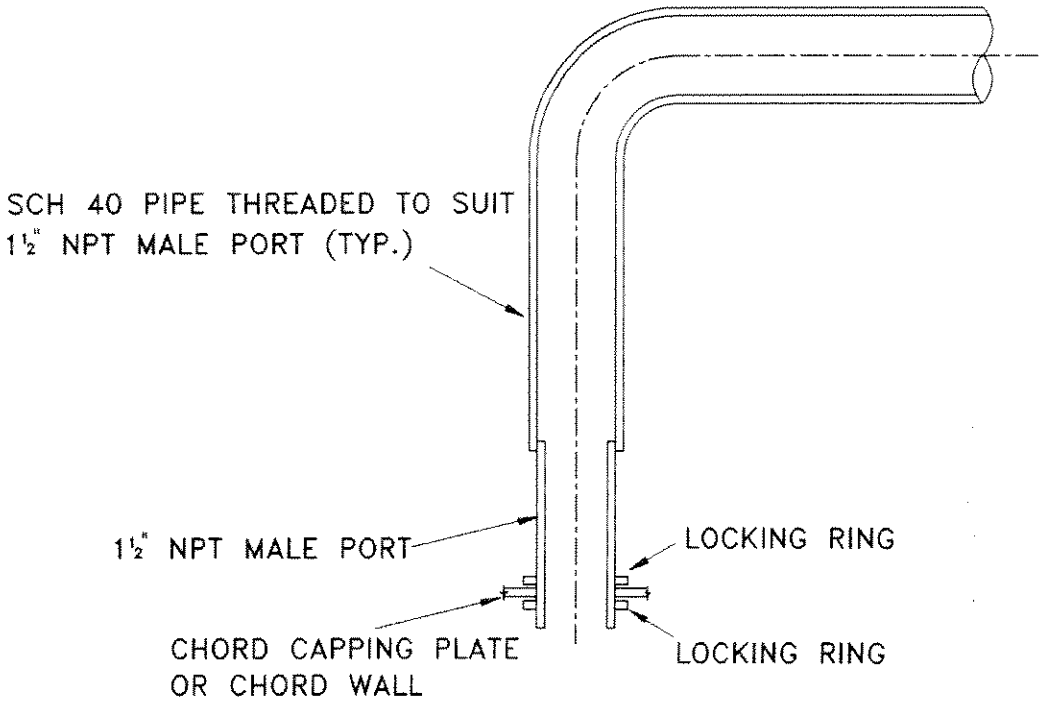


FIGURE 2.2. ARRANGEMENT OF CHORD GROUT OUTLET.

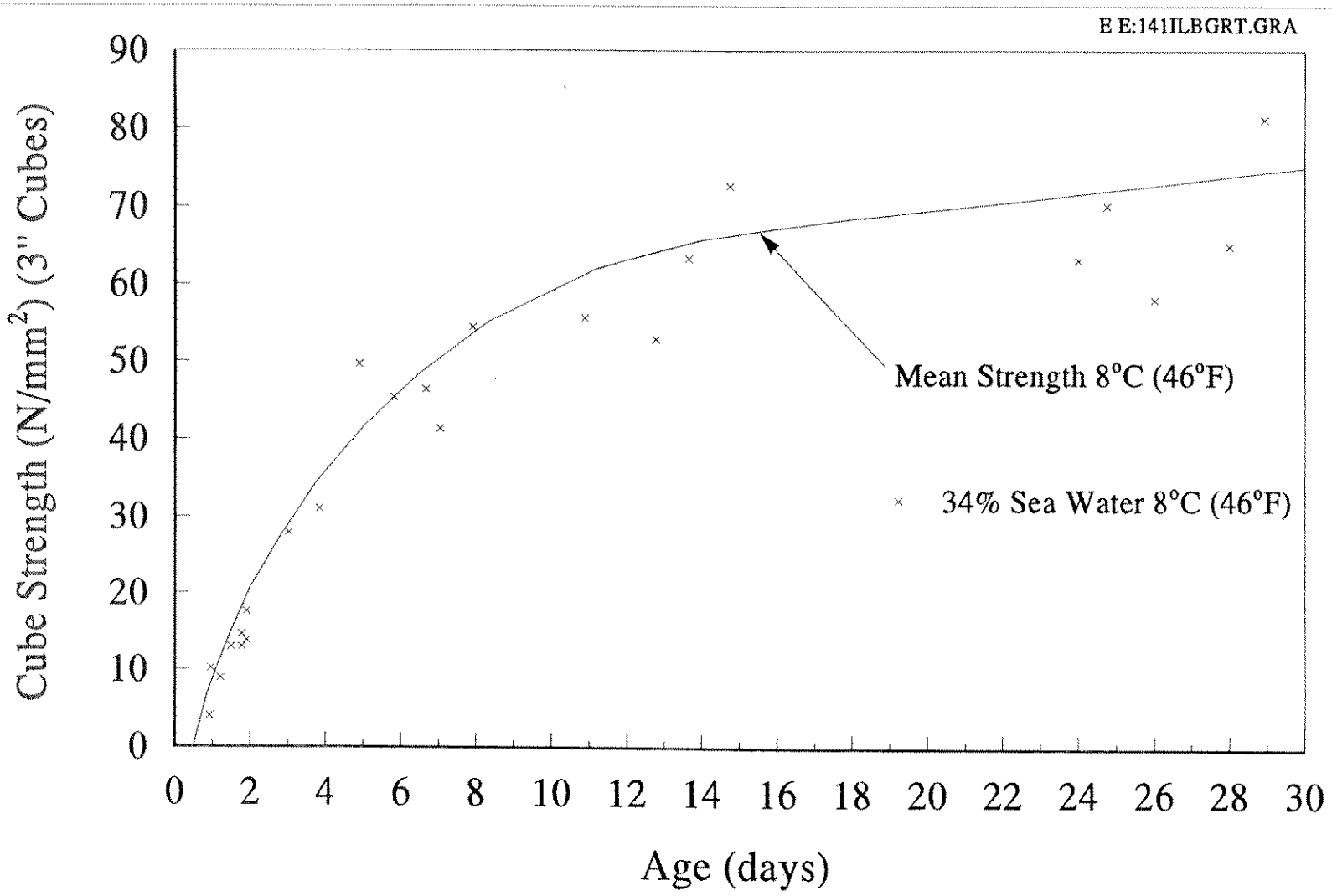


Figure 3 Design Curve for Oilwell B Grout